DOCUMENT RESUME

ED 080 647 UD 013 767

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TITLE	Interaction of Level I and Level II Abilities With Race and Socioeconomic Status.
PUB DATE	73
NOTE	52p.
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	*Ability Grouping; Caucasian Students; Intelligence Tests; *Memory; *Mental Development; *Mental Tests; Negro Students; Nonverbal Tests; Socioeconomic Status; Test Results; Verbal Tests
IDENTIFIERS	California; Lorge Thorndike Intelligence Tests

ABSTRACT

The two-level theory of mental abilities posits two broad classes of ability: level I (learning and memory) and level II (the "g" factor of intelligence tests, reasoning, abstraction, and problem solving). Levels I and II are hypothesized to interact with SES and/or race such that: (1) SES differences are greater for level II than for I, and (2) the correlation between levels I and II, and the regression of level I upon II, are greater in upper than in lower SES populations. These hypotheses are borne out by digit span memory measures and Lorge-Thorndike Verbal and Nonverbal Intelligence Tests, obtained on all the white and black pupils in grades 4-6 in a California school district. Analyses were performed on raw scores, and orthogonal and oblique factor scores. The largest effects in accord with the hypotheses are attributable to differences between the white population (all SES levels) and the low SES black group. One aspect of the two-level theory as originally formulated must be revised in light of the present evidence--i.e. the hypothesis of hierarchical functional dependence of level II performance on level I ability. There appears only to be slight degree of such dependence of level II on level I, and more for Nonverbal than for Verbal intelligence test scores. (Author)

Interaction of Level I and Level II Abilities With Race and Socioeconomic Status[1]

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ABSTRACT

The two-level theory of mental abilities posits two broad classes of ability: Level I (learning and memory) and Level II (the *g* of intelligence tests, reasoning, abstraction, problem solving). Levels I and II are hypothesized to interact with socioeconomic status (SES) and/or race such that (*a*) SES differences are greater for Level II than for Level I abilities, and (*b*) the correlation between Levels I and II, and the regression of Level I upon Level II, are greater in upper than in lower SES populations. These hypotheses are borne out by the present data, consisting of Level I measures (digit span memory) and Level II measures (Lorge-Thorndike Verbal and Nonverbal Intelligence Tests) obtained on all the white and Negro pupils in Grades 4 through 6 in a California school district. Analyses were performed on raw scores and orthogonal and oblique factor scores. The largest effects in accord with the hypothesis are attributable to differences between the white population (all SES levels) and the Low SES Negro group. One aspect of the two-level theory as originally formulated must be revised in light of the present evidence, viz., the hypothesis of a hierarchical functional dependence (i.e., a necessary-but-not-sufficient relationship) of Level II performance upon Level I ability. There appears to be only a slight degree of such dependence of Level II upon Level I, and more for Nonverbal than for Verbal intelligence test scores.

Interaction of Level I and Level II Abilities With Race and Socioeconomic Status[1]

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The present study tests Jensen's Level I-Level II theory of mental abilities in a total school population. The theory has been tested heretofore only with specially selected samples from the population.

The theory and related evidence have been presented in detail elsewhere (Jensen, 1968, 1969a, pp. 109-117; 1969b; 1970a; 1970b; 1973, pp. 193-293; Jensen Rohwer, 1968). Briefly, the theory involves two types of mental abilities, Level I and Level II, and their interaction with population (SES and/or race) differences. Level I ability consists of rote learning and primary memory; it is the capacity to register and retrieve information with fidelity and is characterized essentially by a relative lack of transformation, conceptual coding, or other mental manipulation intervening between information input and output. Level II ability, in contrast, is characterized by mental manipulation of inputs, conceptualization, reasoning, and problem-solving; it is essentially the g factor common to most complex tests of mental ability and standard tests of intelligence. Level I abilities are best measured by rote learning tasks: serial learning, repeated trials of free recall of a number of successively presented familiar uncategorized

objects, pictures, or nouns; and tests of short-term memory, such as digit span. Level II ability is best measured by tests of general intelligence which have a high g loading and especially those of the nonverbal, fluid-intelligence, culture-fair variety.

An interesting point about Level I and Level II abilities is their interaction with socioeconomic status (SES) and race, as has been shown in the articles cited above. The first studies showed mainly that in groups of children selected for low Level II ability (IQs 60 to 80), the low SES children (white or Negro, although SES and race are confounded in some studies) obtain markedly higher scores on Level I tests (usually approaching children with average IQs of 90-110) than are obtained by the middle or upper SES children with the same low IQs. On Level I tasks middle SES children with low IQs perform more in accord with their low IQ, while low SES children perform more like children of average IQ. This finding suggests a lower correlation between Level I and Level II ability in low SES than in middle SES populations. Also, it means that, in general, groups differing in SES should differ less in Level I ability than in Level II. Thus it was suggested that if Level I ability could be made more important in the educative process, there might be a chance of diminishing the present large differences in scholastic performance associated with SES and racial group differences in Level II ability, which is known to correlate highly with scholastic achievement in the prevailing system of education.

The earlier studies were based on a 2 x 2 ANOVA design: high (or middle) SES vs. low SES and high IQ (100-120) vs. low IQ (60-80), thus forming four groups. Typically there were equal numbers of subjects (20 to 40) in each of the four groups. The low IQ groups were often selected from classes for the educable mentally retarded (EMR) with average IQs slightly below 70 (since

75 is the cut-off for admission to EMR classes in California public schools). Because of the difficulty of matching low and high SES groups for high IQ, the "high" IQ groups were usually only slightly above average, (i.e., IQ 105-110). Figure 1 shows the typical results obtained with this design in several studies which used various tests of Level I (i.e., rote learning ability) and of Level II (i.e., intelligence). The SES difference in Level I (learning) ability for

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Insert Figure 1 about here

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the low IQ groups was always highly significant, but the low and high SES groups of "high IQ" (i.e., about IQ 105-110) usually did not differ significantly, although the cross-over or disordinal type of interaction usually appeared as shown in Figure 1. (The interaction term of the 2 x 2 ANOVA was always significant.) The fact that the Level I scores of the high SES group averaged above those of the low SES group for the high IQ condition was not interpreted as a real difference of any psychological significance, but as merely a statistical artifact due to regression. That is, since the high IQ <u>S</u>s of low SES are <u>above</u> their own subpopulation's mean IQ (usually close to 90) and the high IQ <u>S</u>s of high SES are slightly below their subpopulation's mean IQ (usually close to 115), regression should cause the correlated Level I scores of the low SES group to average slightly lower (i.e., closer to their subpopulation mean) than their true-score value and the Level I scores of the high SES group should average slightly higher than their true-score value, thus producing the cross-over seen in Figure 1. It was assumed that the regression lines of the two SES groups are probably no longer linear above the average range of IQ and that low and

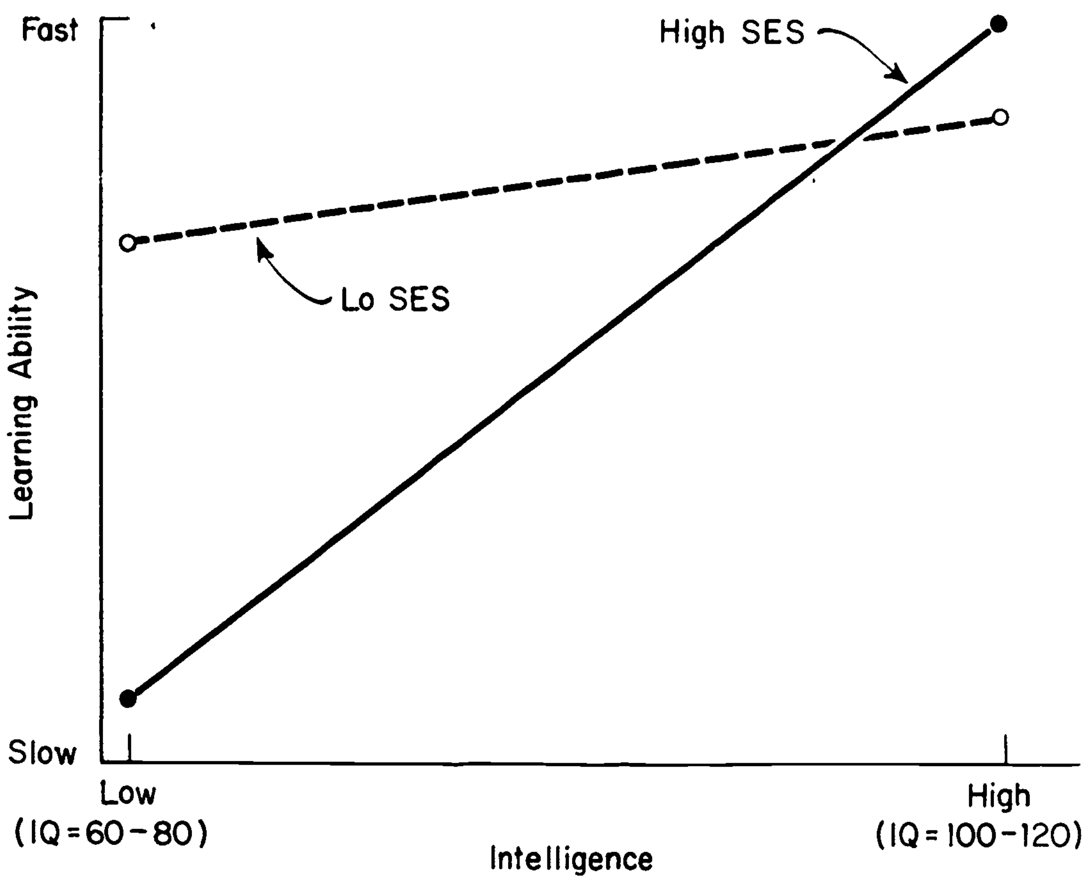

Fig. 1. Summary graph of a number of studies showing relationship between Level I or learning ability (free recall, serial and paired-associate learning) and IQ (Level II ability) as a function of socioeconomic status (SES).

high SES groups in the IQ range above 100 or so would both have the same regression line. (The present study, however, clearly falsifies this assumption and shows that the regression lines [of Level I upon Level II and vice versa] for the lower and upper SES groups are perfectly linear throughout the range of IQs from about 50 to 150.)

The studies employing this 4-group so-called "pseudo-orthogonal" design were criticized on methodological grounds by Humphreys and Dachler (1969a, 1969b; also see Jensen, 1969b). Humphreys and Dachler contended that these findings regarding the interaction of SES with Level I and Level II abilities were probably an artifact of the pseudo-orthogonal design and the method of selecting extreme groups. They wrote:

"There are difficulties in Jensen's experimental designs which probably account for his results . . . He uses correlated variables in an orthogonal analysis of variance design without knowing the sizes of the populations from which he has sampled. Secondly, it is probable that low-IQ--high-SES children in the public schools constitute a biased sample of all such children. The combination of the design error and the sampling assumption are sufficient to account for the relationships Jensen has reported. It can be concluded that Jensen's published results can be disregarded and that unbiased data lend no support to this theory" (p. 426).

Humphreys and Dachler also analyzed some data from Project TALENT, which provided rather questionable measures of Levels I and II and failed to accord with Jensen's findings (Jensen, 1969b).

But then Fischbach and Walberg (1971) claimed:

"The methods used by Humphreys and Dachler to estimate effects in their analysis of Project TALENT data to test Jensen's Theory of Intelligence are shown to produce biased estimates" (p. 79). And, "Humphreys and Dachler (1969)

advocate estimation of the effects of intelligence (IQ), socioeconomic status, and the interaction by linear combinations of cell means weighted by weights proportional to the cell frequencies [in the total population] rather than the usual linear combinations of the unweighted cell means [as in Jensen's analyses]. It is easy to show, however, that these weighted estimators are biased while the ones based on the unweighted cell means are not" (p. 79). ". . . when designing a study there is no need to be concerned about the relative number of persons in each of the four populations. The best and most economical method of gaining information about the parameters is to sample each group equally (unless, of course, there are sampling cost differentials)" (p. 80).

From this it would appear that Jensen had proceeded properly as far as experimental design is concerned, and that the Humphreys and Dachler criticism is incorrect on this issue. This point is still being debated and will have to be settled by mathematical statisticians.

The other criticism made by Humphreys and Dachler, _viz_., that selecting pupils from special classes may have biased the data such as to make them unrepresentative of the relationships among the test variables in the total school population, however, is well taken.

In order to obtain a more definitive answer to these criticisms than was possible at the time they were made, we have gotten around the problem of the pseudo-orthogonal design by testing the entire school population of one whole public school district in California, and we have avoided the question of atypical subjects in special classes by using only children in regular classes. Such data should allow a most stringent and powerful test of the hypotheses in question. But before proceeding further, we should formalize these hypotheses as explicitly as possible, so that the empirical consequences of the theory are perfectly clear; then if the theory is wrong it can be disproved by the

evidence as unambiguously as possible.

In the simplest, most extreme form, the theory states:

(a) Social classes do not differ, on the average in Level I ability, but differ on Level II ability. (Another way of stating this is that Level I ability is not correlated with SES and Level II ability is positively correlated with SES.) This hypothesis is expressed graphically in Figure 2.

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Insert Figure 2 about here

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(b) The regression of Level I upon Level II ability is greater (i.e., steeper slope of the regression line) in upper and middle SES populations than in low SES populations. A less general corollary of this is that the correlation between Level I and Level II is greater in upper and middle SES populations than in low SES populations. It is less general because restriction of the range-of-talent can affect the size of the correlation coefficient, whereas the slope of the regression line remains the same even if the distribution on one or both of the variables is truncated and the variance is thereby reduced. The correlation is lowered, therefore, but the slope of the regression line remains unchanged. The slope of the regression line (of Level I on Level II), therefore, is a more stable and fundamental datum and also expresses more directly the relationships shown in Figure 1. Thus, a proper test of the hypothesis should involve testing the difference in the regression of Level I upon Level II in low and middle SES groups, and not just testing the SES difference in the correlations between Level I and Level II. If the results for the

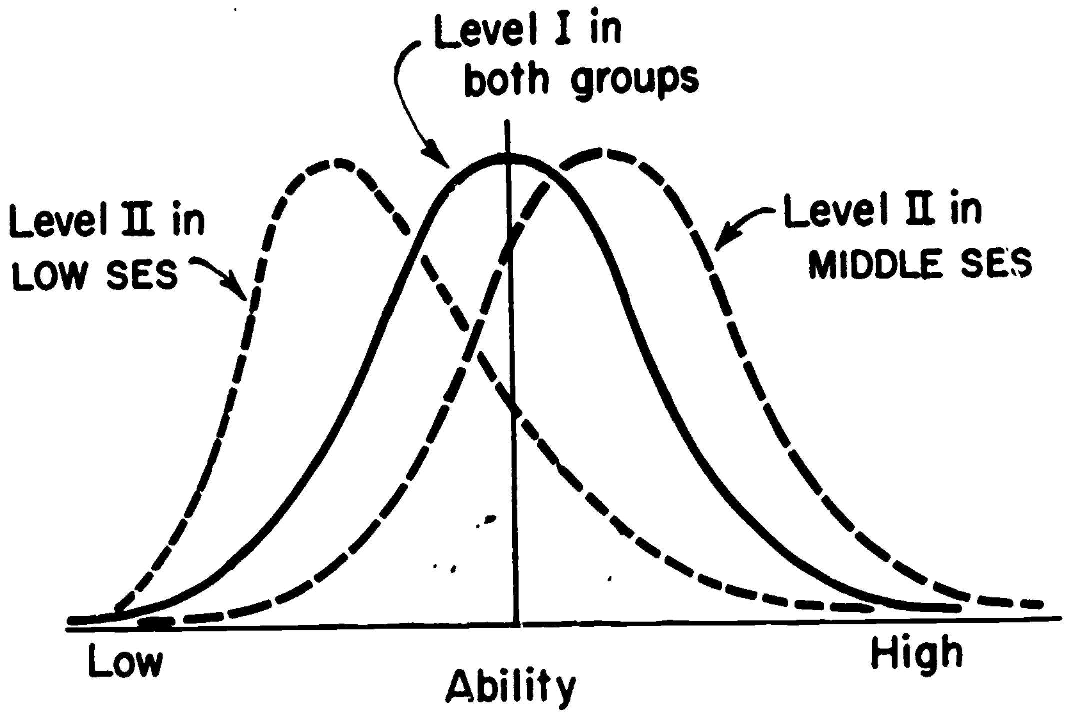

Fig. 2. Hypothetical distributions of Level I (solid line) and Level II (dashed line) abilities in middle-class and lower-class populations.

regression and the correlation go in significantly opposite directions with respect to the hypothesis, it could only mean that the two SES groups have significantly different variances on Level I or Level II or both. But the hypothesis depicted in Figure 1 depends essentially upon the difference in slope between the two lines, with the low SES group showing the lesser slope. Thus the crucial test of the hypothesis must be the test of difference between slopes rather than between correlations.

This hypothesis is expressed graphically in Figure 3, which depicts the differing slopes of the regression lines of Level I upon Level II in middle (M) and low (L) SES populations which have different means ($\bar{X}_L$ and $\bar{X}_M$) on Level II ability and the same mean ($\bar{X}_{L,M}$) on Level I ability. (This is essentially the same picture as the empirical findings summarized in Figure 1, but those findings are based on the means of rather extreme groups which are merely connected by straight lines; they are not true regression lines determined by a random or truly representative sample of the normal school population.

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Insert Figure 3 about here

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The regression of Level II upon Level I has not been a part of the theory and cannot be inferred from the theory unless certain assumptions are made, assumptions for which at this point there seems to be no real theoretical basis. The lines of regression of Level II upon Level I can be determined only if we assume a precise value of the correlations between Levels I and II in low and middle SES groups. The theory posits no precise values, for no specific value

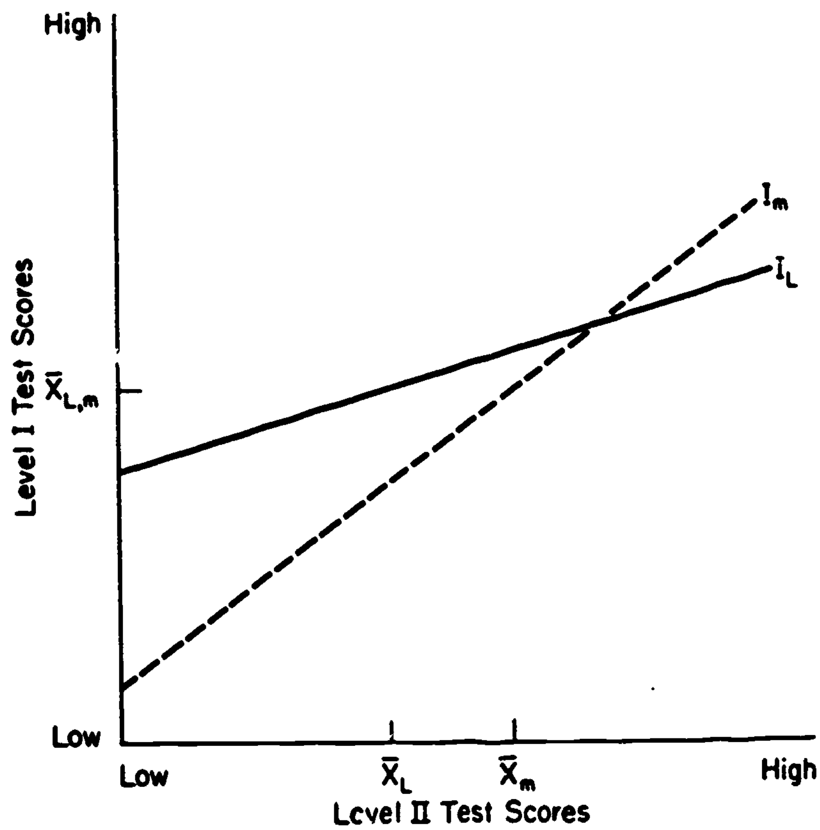

Fig. 3. Hypothetical regression of Level I ability (I) upon Level II ability in middle (m) and lower (l) class populations.

exists for the general case. The correlations are merely population parameters which may vary according to the populations sampled and the method of classifying individuals by SES group. The theory only posits that the regression coefficient (i.e., slope) of Level I on Lever II is <u>greater</u> (i.e., steeper slope) in middle SES than in low SES populations. The posited difference thus is <u>directional</u> rather than precisely quantitative. If the variances are assumed to be the same in the middle and low SES groups (an assumption which is independent of the theory), then the correlation between Level I and II will be greater in the middle than in the low SES group. Assuming this to be the case, then, the regression lines (of Level II upon Level I) should gradually converge. But the convergence would be very gradual, and assuming realistic values of the Level I-II correlations in the low and middle SES groups, there would be no point within $\pm 3\ \sigma$ of the mean of a normal distribution (which includes 99.74% of the population) of Level I scores at which low and middle SES groups matched on Level I ability would be equal in Level II ability or where the low SES group would exceed the middle SES group in Level II ability. If the means of the low and middle SES groups were assumed to differ by $1\ \sigma$, and if the Level I-Level II correlations were .6 and .4 in the middle and low SES groups, respectively, we would have to match <u>S</u>s from the two SES groups for Level I scores at least 5σ below the common Level I mean in order for the low SES <u>S</u>s, on average, to equal or exceed the middle SES <u>S</u>s on Level II ability. But any <u>S</u>s who were 5σ below the mean on Level I ability would be in the range of severe mental defect, at the imbecile or idiot level where the deficit is more likely due to a major gene or chromosomal anomaly or to organic damage, rather than to the normal variations in the polygenic and environmental determinants of mental variation that operate in the bulk of the population. For most of the normal population, the regression lines of Level II upon Level I for the two SES groups would be practically parallel. Estimating the point of convergence at 5σ below the mean

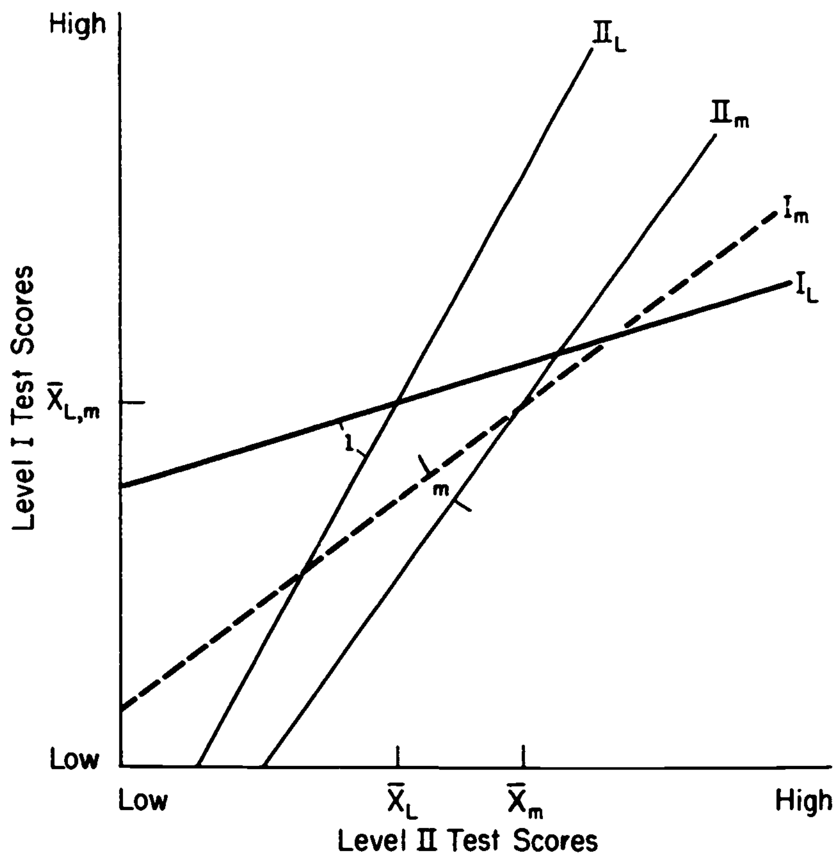

Fig. 4. Hypothetical regression lines for relationship between Level I and Level II abilities in middle and lower class populations.

assumes linearity of regression all the way down into the range of severest mental defect, and since the causal factors in that range are different than for the rest of the distribution, such an assumption is quite unwarranted. Within reasonable boundary conditions for the operation of the theory, the lines of regression of Level II upon Level I should be pictured as almost parallel, with such slight convergence that the lines would not come together within the range of abilities normally found in the public schools. If we add these hypothetical regression lines to Figure 3, we get the picture shown in Figure 4. As can be seen, the angles (_l_ and _m_) between the regression lines are different for the lower (_l_) and middle (_m_) SES groups, being smaller for the middle SES. (The cosine of the angle between the regression lines is equal to the correlation coefficient when σ is the same on both variables or the scores are standardized with the same σ.)

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Insert Figure 4 about here

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(_c_) The third element of the theory concerns the hierarchical relationship between Level II and Level I ability. The development of Level II ability, as well as Level II performance itself, is seen as having some functional dependence upon Level I ability, but not the reverse. For example, initial learning of the information and cognitive skills involved in Level II performance may depend in part upon short-term memory and its consolidation, which are Level I processes. Thus an individual with superior Level I ability will in the long-run show better Level II performance than will a person with the same genetic

and environmental potential for Level II ability but with poorer Level I ability. Also, it seems reasonable to suppose that some short-term memory can be involved in solving Level II problems, such as Raven Matrices items or the mental arithmetic subtest of the Wechsler scale, in which information must be retained in memory (i.e., Level I) while mental operations are being performed on it (i.e., Level II). A relatively pure Level I test, such as digit span memory, on the other hand, can hardly be seen as depending upon the processes of abstraction, generalization, and conceptualization that are called for in Level II tests.

Another way of stating the hierarchical relationship between Levels I and II, that is, the functional dependence of Level II upon Level I ability, is to say that Level I is necessary but not sufficient for the development and operation of Level II ability. A consequence of this hierarchical formulation would be that one would seldom if ever find individuals with very high Level II ability who have very low Level I ability. The reverse, however, would not be uncommon, i.e., persons with high Level I ability but low Level II ability. (In fact, there are known to exist quite extreme idiot savants of this type.) As Matarazzo (1972, p. 204) has noted in connection with the clinical use of the Wechsler intelligence test, a low score on memory span for digits is highly related to general mental retardation, while a high score on digit span is not highly indicative of superior general intelligence. Matarazzo states, "Ordinarily, an adult who cannot repeat at least four or five digits forward is [in about 9 cases out of 10] either organically impaired or mentally retarded. Nevertheless, mental retardates sometimes do well on the Memory Span Test" (p. 205). This observation suggests a hierarchical (or necessary-but-not-sufficient) type of relationship between Levels I and II.

If this is in fact the case, the dispersion (i.e., the standard error of estimate) of Level I scores about the line of regression of Level I upon Level II should show a gradual and regular decrease in going from lower to

higher scores on Level II. Thus the relative magnitudes of the standard error of estimate of Level I scores for low and high scores on Level II provide a test of the hypothesis of hierarchical dependence of Level II upon Level I. That is, if the hypothesis is true, we should expect to find a larger dispersion of Level II scores in the lower range of Level I scores than in the higher range of Level I scores.

The purpose of the present study is to test each of these three main hypotheses (described above under _a_, _b_, and _c_) derived from the Level I-Level II theory of mental abilities.

Method

Subjects

The 2,612 _S_s in this study consisted of virtually all the white (N = 1,489) and Negro (N = 1,123) children enrolled in regular classes of the 4th, 5th, and 6th grades from all 14 elementary schools of the Berkeley Unified School District in California.

The small percentage of children who were absent on the particular day that their class was tested are not included in this study. Also, test data on all children not classified in the school records (and according to their own parent(s)) as either white or Negro were excluded from the present study. (These excluded _S_s, mostly Orientals, comprised about 10% of the total school population.)

The adult white population in this district is largely of middle or upper-middle SES; the three largest employers (mostly of whites) are the University, the Lawrence Radiation Laboratory, and a large pharmaceutical firm, all of which employ workers with better than average education and SES for the white population as a whole. The adult Negro population is predominantly lower-middle to low SES, comprised largely of semiskilled and unskilled workers, although it

is a somewhat higher SES group than the Negro populations in the surrounding communities, with fewer unemployed and on welfare.

All tests were group-administered to the regular classrooms by a staff of testers (3 whites and 3 Negroes) who were specially employed and trained for this purpose. The white and Negro testers were assigned to classes at random. In any given class, the Level I and Level II tests were always administered by different testers on different days never more than one week apart. Thus the correlations between the Level I and Level II tests would not be systematically affected by any individual tester biases.

Tests

Control Tests. Two different "control" tests were used, one in each of the two testing sessions. The main purposes of the control tests were to set a good test-taking attitude in the class, emphasizing attention and effort while at the same time lessening tension and text anxiety by giving Ss tasks they could perform successfully simply by being attentive and trying their best.

The Listening-Attention Test is given just before the Level I test (Memory for Numbers). The L-A Test measures the child's ability to attend to and follow orally given directions paced at 2-second intervals by means of a tape recording. The child is presented with an answer sheet containing 100 pairs of digits in sets of 10. The child listens to a tape recording which speaks one digit every two seconds. The child is required to put an X over the one digit in each pair which has been heard on the tape recorder. The purpose of this test is to determine the extent to which the child is able to pay attention to numbers spoken on a tape recorder, to keep his place in the test, and to make the appropriate responses to what he hears from moment to moment. Low scores on this test indicate that the subject is not up to validly taking

the Memory for Numbers test which immediately follows. High scores on the Listen-Attention Test indicate that the subject has the prerequisite skills for taking the digit span (Memory for Numbers) test. The Listening-Attention Test thus is intended as a means for detecting students who, for whatever reason, are unable to hear and to respond to numbers read over a tape recorder. The test itself makes no demands on the child's memory, but only on his ability for listening, paying attention, and responding appropriately--all prerequisites for the digit memory test that follows.

The Speed and Persistence Test (Making Xs) was always given just before the Level II tests (Lorge-Thorndike IQ). The Making Xs Test is intended as an assessment of test-taking motivation. It gives an indication of the subject's willingness to comply with instructions in a group testing situation and to mobilize effort in following those instructions for a brief period of time. The test involves no intellectual component, although for young children it probably involves some perceptual-motor skills component, as reflected in other studies by increasing mean scores as a function of age between grades 1 to 5. Individual differences among children at any one grade level would seem to reflect mainly general motivation and test-taking attitudes in a group situation. Children who do very poorly on this test, it can be suspected, are likely not to put out their maximum effort on ability tests given in the same group situation, and to that extent their ability test scores are not likely to reflect their real level of ability.

The Making Xs Test consists of two parts. On Part I the subject is asked simply to make Xs in a series of squares for a period of 90 seconds. In this part the instructions say nothing about speed. They merely instruct the child to make Xs. The maximum possible score on Part I is 150, since there are 150 squares provided in which the child can make Xs. After a 2-minute rest period the child turns the page of the test booklet to Part II. Here the child

is instructed to show how much better he can perform than he did on Part I and to work as rapidly as possible. The child is again given 90 seconds to make as many Xs as he can in the 150 boxes provided. The gain in score from Part I to Part II reflects both a practice effect and an increase in motivation or effort as a result of the motivating instructions, i.e., instructions to work as rapidly as possible.

Level I Test. Previous studies have indicated that one of the most unambiguous and reliable Level I measures is digit span memory. A specially devised test of such memory, which has much higher reliability than the short digit span tests included in such general test batteries as the Stanford-Binet and the Wechsler, is the writer's Memory for Numbers Test. It has three parts. Each part consists of six series of digits going from four digits in a series up to nine digits in a series. The digit series are presented on a tape recording on which the digits are spoken clearly by a male voice at the rate of precisely one digit per second. The Ss write down as many digits as they can recall at the conclusion of each series, which is signaled by a "bong." Each part of the test is preceded by a short practice test of three digit series in order to permit the tester to determine whether the child has understood the instructions, etc. The practice test also serves to familiarize Ss with the procedure of each of the subtests. The first subtest is labeled Immediate Recall (I). Here S is instructed to recall the series immediately after the last digit has been spoken on the tape recorder. The second subtest consists of Delayed Recall (D). Here S is instructed not to write down his response until after ten seconds have elapsed after the last digit has been spoken. The ten-second interval is marked by audible clicks of a metronome and is terminated by the sound of a bong which signals the S to write his response. The Delayed Recall condition invariably results in some retention decrement. The third subtest is the repeated series test, in which the digit series is

repeated three times prior to recall; the S then recalls the series immediately after the last digit in the series has been presented. Again, recall is signaled by a bong. Each repetition of the series is separated by a tone with a duration of one second. The repeated series almost invariably results in greater recall than the single series. This test is very culture fair for children in second grade and beyond and who know their numerals and are capable of listening and paying attention, as indicated by the Listening-Attention Test. The maximum score on any one of the subtests is 39, i.e., the sum of the digit series from four through nine. Only the total score (i.e., the sum of the scores on the three subtests) is used in the present study.

Level II Tests. Level II was measured by the Lorge-Thorndike Intelligence Test (Level 3, Form B), which has two parts, Verbal and Nonverbal. This is a nationally standardized group-administered test of general intelligence. In the normative population, which was intended to be representative of the nation's school population, the test has a mean IQ of 100 and a σ of 16. The test is primarily a measure of reasoning ability; it has a high g saturation when factor analyzed with other mental ability tests, so it is deemed a good Level II test, especially the nonverbal part which is based on pictorial problems and depends not at all upon reading skill or scholastic knowledge.

Results

Control Tests

Table 1 presents summary statistics on the Listening-Attention Test.

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Insert Table 1 about here

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Table 1

Statistics on the Listening-Attention Test

for White (W) and Negro (N) Groups

Statistic	Grade 4		Grade 5		Grade 6	
	W	N	W	N	W	N
N	504	411	477	416	442	387
Mean	98.3	98.2	99.3	98.6	99.6	99.2
SD	11.9	7.6	6.1	6.0	5.1	5.8
Median	100.0	100.0	100.0	100.0	100.0	100.0
25th %ile	100.0	100.0	100.0	100.0	100.0	100.0
75th %ile	100.0	100.0	100.0	100.0	100.0	100.0

Since a perfect score on this test is 100, it is evident that the vast majority of Ss were motivated to do their best in the test situation and were capable of correctly hearing the numerals as spoken over the tape recording and of properly following directions and registering their responses on answer sheets. Practically all Ss obtained a perfect score. At this age level, there is no appreciable difference between the grades or between whites and Negroes on the Listening-Attention Test. Since the correlation between the Listening-Attention test and either the Memory Test or the Lorge-Thorndike Intelligence Tests are not significantly greater than zero in the white or Negro group, it is clear that no significant amount of the variance in these tests is attributable to differences in the kind of sustained attentiveness and willingness to comply with instructions that are assessed by the Listening-Attention Test.

Table 2 gives the statistics on the Speed and Persistence Test (Making Xs). On this test the Negro group scores significantly higher than the white

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Insert Table 2 about here

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group on both the first and second try and on the gain score (i.e., the difference between 2nd Try-1st Try), and these differences are fairly consistent across the three grades. These results, like those for the Listening-Attention Test, indicate that at least equally good cooperation and effort in the test situation were put forth by the Negro Ss as by the white Ss. The lower quartile scores (25th %ile in Table 2) should be a most sensitive indicator of children who are not cooperating or putting out much effort, and we see that at every grade the performance of Negro Ss equals or exceeds that of the white Ss.

Table 2

Statistics on Speed and Persistence Test (Making Xs) in White and Negro Groups

Statistic	Grade 4						Grade 5						Grade 6					
	White (N = 542)			Negro (N = 432)			White (N = 498)			Negro (N = 419)			White (N = 548)			Negro (N = 391)		
	1st Try	2nd Try	Gain	1st Try	2nd Try	Gain	1st Try	2nd Try	Gain	1st Try	2nd Try	Gain	1st Try	2nd Try	Gain	1st Try	2nd Try	Gain
Mean	64.5	77.9	13.4	74.3	88.7	14.3	82.4	94.7	12.3	82.4	97.5	15.1	95.1	107.3	12.2	93.4	108.7	15.4
SD	26.7	24.3	15.3	26.6	21.9	17.6	26.2	24.9	13.8	28.6	23.3	18.2	25.2	22.6	17.3	29.7	25.6	20.3
Median	60.0	80.0	10.0	78.0	91.0	10.0	87.0	97.0	10.0	86.0	101.0	12.0	99.0	111.0	8.0	99.0	111.0	13.0
25th %ile	42.0	56.5	4.0	52.0	75.0	3.0	61.5	82.5	3.0	62.0	85.0	4.0	79.0	98.0	1.0	77.0	97.0	5.0
75th %ile	86.0	97.0	20.0	94.0	105.0	22.0	101.0	111.0	18.0	103.0	114.0	22.7	113.0	122.0	18.0	114.7	125.0	24.7

These results contradict the common notion that Negro children have a slower "personal tempo" or are less cooperative or more lackadiasical in a test situation. The correlations between Making Xs and the Memory for Numbers and Lorge-Thorndike intelligence tests are close to zero in both racial groups.

Mean White-Negro Difference in Memory (Level I) and Intelligence (Level II) Tests

The hypothesis in its most simple and extreme form states that low and middle SES groups differ in Level II but not in Level I ability (as depicted in Figure 2). Table 3 shows the raw score means on the Level II and Level I tests in the white and Negro groups, and (in the last column) shows the group difference in terms of the white sigma (standard deviation). We see that although the

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Insert Table 3 about here

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white-Negro difference is highly significant both on the memory and on the intelligence tests, the difference on the intelligence tests is almost two and one-half times greater than the difference in the memory test. It is thus unclear whether this finding disproves or supports the hypothesis. It would seem to disprove the "no difference on Level I" aspect of the hypothesis, and yet the results are consistent with the hypothesis in that the white-Negro difference on the memory test is very much less than the difference on the intelligence test. Since the theory also posits a correlation between Level I and Level II, and a higher correlation in higher than in lower SES groups, we should expect a Level I difference between the present white and

Table 3

Raw Score Means and SDs on Intelligence (Level II) and Memory Tests (Level I) and Mean White-Negro Differences in White Sigma Units

	White (N = 1,489)		Negro (N = 1,123)		$(\bar{W}-\bar{N})/\sigma_W$
Variable	Mean	SD	Mean	SD	
Age (Mos.)	131.23	10.89	132.61	11.24	-.13
Intelligence					
Verbal	69.85	12.56	46.24	16.88	1.88
Nonverbal	63.12	10.83	43.47	14.50	1.81
Memory					
Immediate	23.33	6.41	18.75	6.61	.71
Repeat	26.89	5.81	23.40	6.56	.60
Delay	24.25	5.76	20.29	6.73	.69
Total	74.48	15.58	62.45	16.82	.77

Negro groups if the IQ of the white group is above the white mean for the general population or if the present Negro group is below the general Negro mean IQ. In the general population, the groups differ by only about 1 σ or 16 IQ points, while in our Berkeley population the difference is considerably greater. In terms of the Lorge-Thorndike national norms, the means of the present white group are: Verbal IQ = 118.4, SD = 15.7; Nonverbal IQ = 120.24, SD = 14.6. The means of the present Negro group are Verbal IQ = 92.8, SD _ 13.9; Nonverbal IQ = 95.4, SD = 15.5. The consequences of this difference between the groups used in the present study and the averages for the general U. S. population can be more easily discussed in a later section in connection with the regression of memory scores upon intelligence scores.

Correlations Between Memory and Intelligence

The hypothesis predicts a higher correlation between Level I and Level II in the higher SES (white) group than in the lower SES (Negro) group, assuming equal or similar variances in both SES groups.

The correlation (Pearson r) between the Verbal intelligence raw scores and total memory scores is .466 in the white group (N = 1,489) and .420 in the Negro group (N = 1,123). The difference is appropriately tested by a one-tailed test, since the hypothesis predicts the sign of the difference in correlations; the one-tailed p value is .07. The correlation between memory and nonverbal intelligence is .443 for whites and .372 for Negroes, and the one-tailed $p <$ .02.

But these correlations are based on significantly unequal variances in the intelligence test scores in the white and Negro groups. We must rule out the possibility that the correlations differ only because of the unequal variances in the two groups. The correlations can be corrected for restriction of range, which in effect equalizes the variances of the two groups. The

method is explicated by Guilford (1956, pp. 320-321). The corrected _r_ between Total Memory and Lorge-Thorndike Verbal is .610 for whites and .420 for Negroes. This difference is highly significant (z = 6.59, one-tailed $p < 10^{-6}$). The corrected _r_ between Total Memory and Lorge-Thorndike Nonverbal is .585 for whites and .372 for Negroes, also a highly significant difference (z = 7.07, one-tailed $p < 10^{-6}$). When these correlations are also corrected for attenuation and chronological age (in months) is partialed out of the correlations, the correlation between Total Memory and Lorge-Thorndike Verbal is .66 for whites and .45 for Negroes (z = 7.66, one-tailed $p < 10^{-6}$); and between Total Memory and Lorge-Thorndike Nonverbal is .63 for whites and .40 for Negroes (z = 8.14, one-tailed $p < 10^{-6}$).

Thus the present data strongly support the hypothesis that the Level I and Level II measures are more highly correlated in the higher SES (white) than in the lower SES (Negro) population.

Regression of Memory Upon Intelligence

The hypothesis predicts a steeper slope of the regression line of Level I (Memory) scores upon Level II (intelligence) scores in the white group than in the Negro group. Figures 5 and 6 show the relevant regression lines. A statistical test of departure from linearity was applied to all the regressions and none was found to depart significantly (at the .10 level) from linear regression. Though the linearity of the regression appeared to extend throughout the entire range of scores for both racial groups--a total range of more than 100 IQ points beginning at about IQ 50--regression lines shown in the following figures were drawn to extend only over the range of scores which permit an unequivocal test of departure from linearity. (The _N_s at the very extremes of the distributions (less than the upper and lower 2.5 percent) are too small and scattered to permit statistical confidence of linearity in the regions

beyond approximately the middle 95% of the distributions.)

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Insert Figures 5 and 6 about here

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We see in Figures 5 and 6 that the regression is greater for whites than for Negroes. For Lorge-Thorndike Verbal (Figure 5) the regression, $\underline{b}$, is .58 for whites and .42 for Negroes. A test[3] of the significance of the difference between the two slopes is highly significant ($\underline{t} = 4.10$, $\underline{p} < 4 \times 10^{-5}$). For Lorge-Thorndike Nonverbal (Figure 6), the white-Negro difference in slope is also highly signficant ($\underline{t} = 4.35$, $\underline{p} < 10^{-5}$).

According to the norms provided by the Lorge-Thorndike Test Manual the point on the scale of raw scores at which the regression lines for the present white and Negro groups cross over is equivalent to a Lorge-Thorndike IQ of approximately 100, both for the Verbal and the Nonverbal tests. In the range of intelligence below IQ 100, the Negro children, on the average, surpass white children in memory scores; and in the range above IQ 100, the white children surpass the Negro children in memory performance. The cross-over in the above-average IQ range is clearly not a statistical artifact as was originally believed when only small sample data based on selected groups were available. These results mean that, on the average, the white child below approximately IQ 100 has a poorer memory span than his Negro counterpart in IQ, and the white-Negro difference increases, in favor of the Negro child, the lower the IQ. In terms of national IQ norms, the approximately 80 to 85 percent of Negro children who fall below IQ 100 would, on the average, surpass in memory span the 50 per cent of white children who fall below IQ 100. If we assume that the white and Negro regressions in the general U.S. population are the

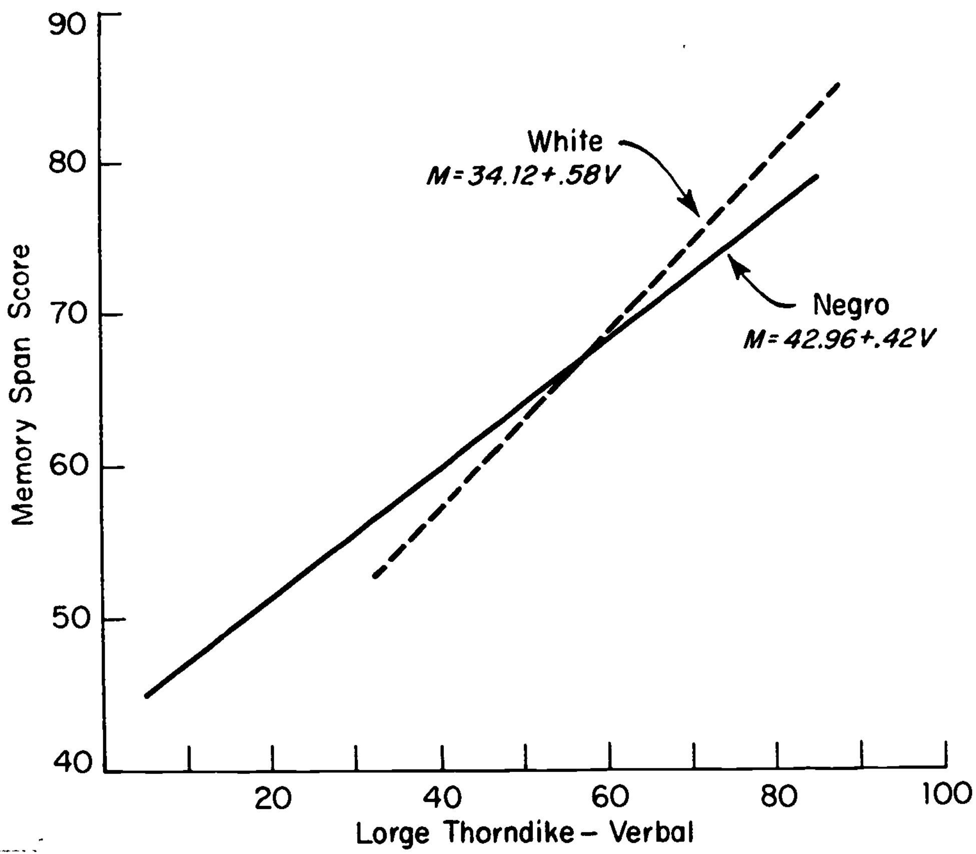

Fig. 5. Regression of Memory scores upon Lorge-Thorndike Verbal Intelligence raw scores in white and Negro groups.

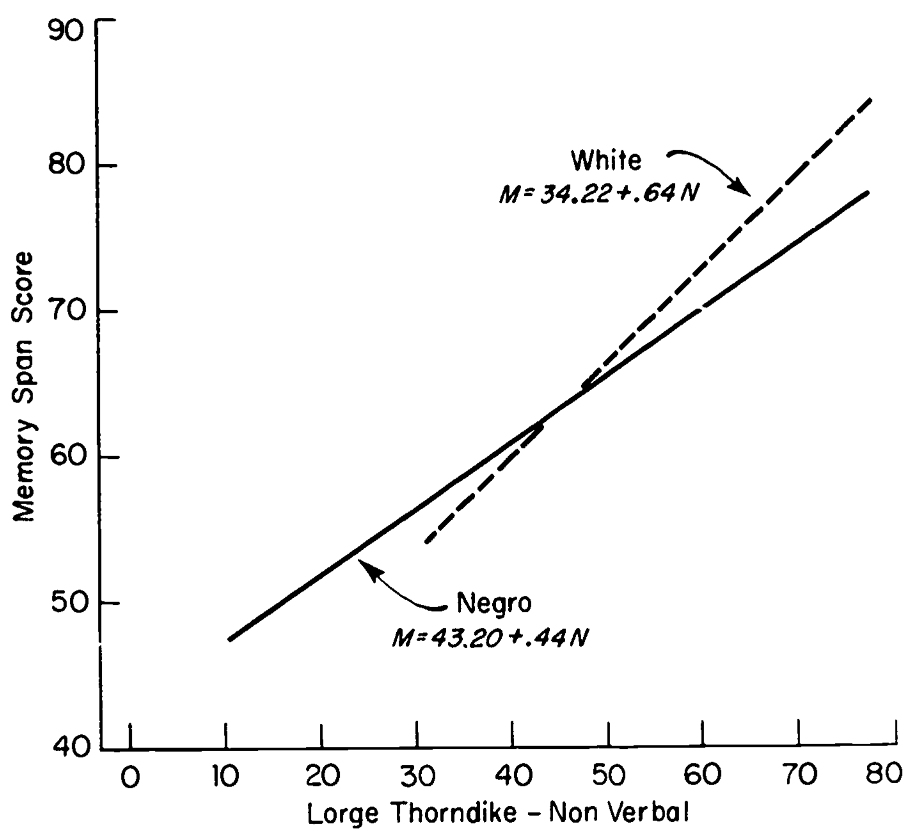

Fig. 6. Regression of Memory scores upon Large-Thorndike Nonverbal Intelligence raw scores in white and Negro groups.

same as those in the present data, and if the general white and Negro IQ means are 100 and 85, respectively, then, according to the regression equations in Figures 5 and 6, we should expect the white and Negro populations (which differ 1 σ in IQ) to differ by only about 0.3σ to 0.4σ in memory span, in favor of whites. That is to say, the present data do not support the hypothesis of no white-Negro difference in Level I (here measured by the Memory Test), but the data do indicate a much smaller racial difference in memory than in IQ. This conclusion would, of course, not hold if the relative slopes of the regression lines for the two races are not about the same in the general population as in the Berkeley school population. The rather atypical nature of the Berkeley population with respect to mean Lorge-Thorndike IQ, especially in the white population, should make us wary of generalizing to the general population or to the populations of other communities with markedly different demographic and SES features than in Berkeley.

<u>Regression of Intelligence Upon Memory</u>

These regression lines present a very different picture from that of the regression of memory upon intelligence. As seen in Figures 7 and 8, the

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Insert Figures 7 and 8 about here

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slopes of the regression lines for whites and Negroes are parallel or nearly so; (the regression coefficients do not differ significantly) and they are separated by approximately 1.8 σ on the intelligence scales. Thus there is

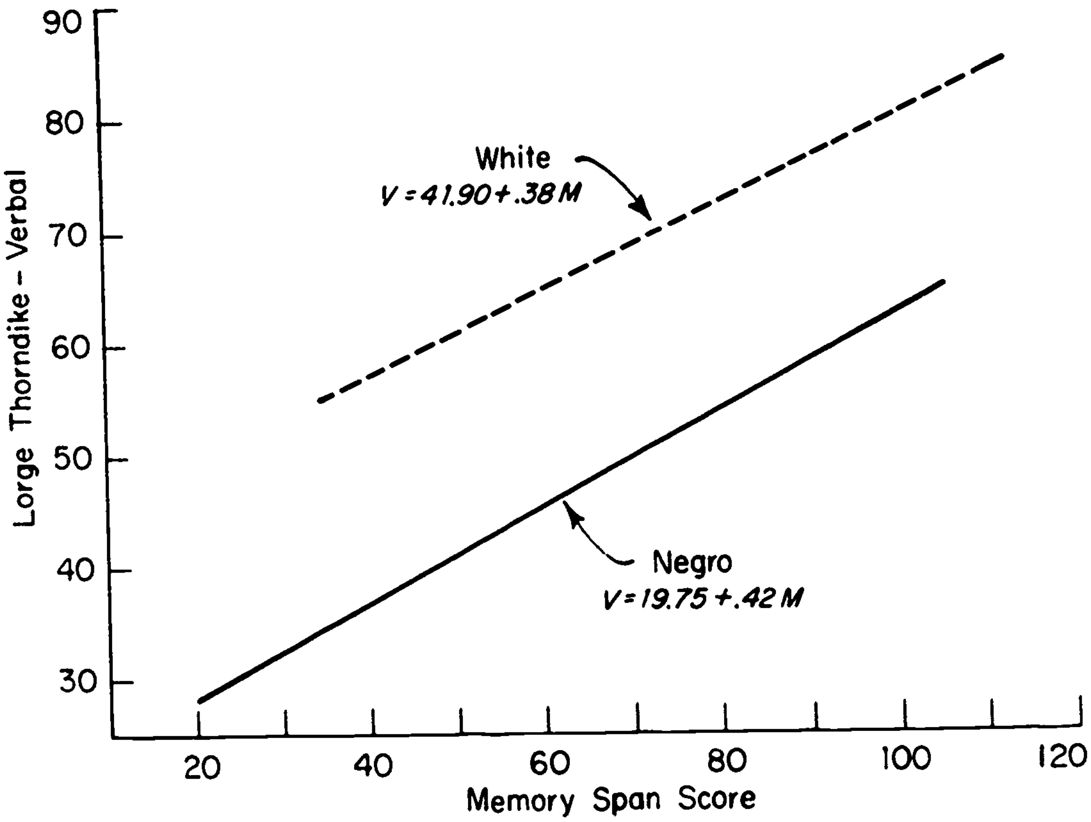

Fig. 7. Regression of Lorge-Thorndike Verbal raw scores upon Memory scores in white and Negro groups.

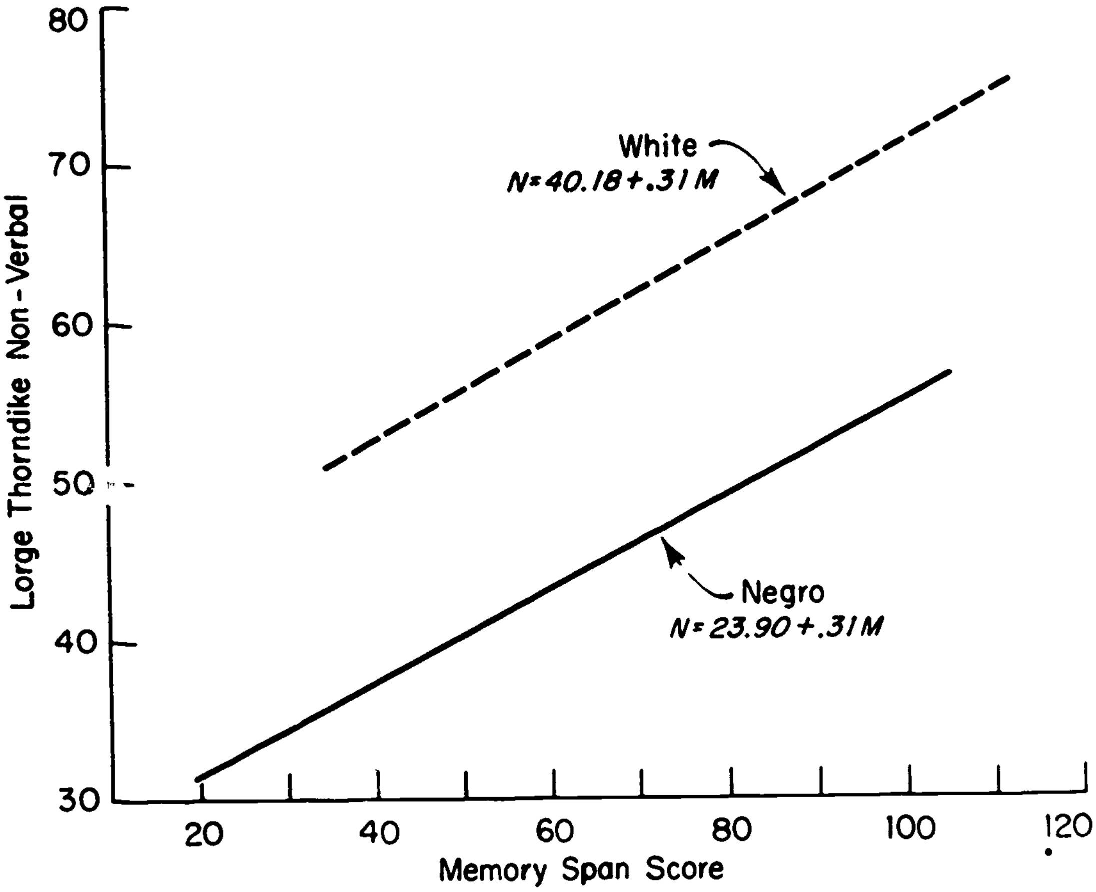

Fig. 8. Regression of Lorge-Thorndike Nonverbal raw scores upon Memory scores in white and Negro groups.

no point on the scale of memory scores at which equated groups of whites and Negroes obtain equal intelligence scores. The picture is close to the hypothetical regression lines depicted in Figure 4. It would seem to be consistent with the hypothesis that Level I is necessary-but-not-sufficient for the development and functioning of Level II. Why should white and Negro children with precisely the same memory performance differ by 1.8 on both the Verbal and Nonverbal intelligence measures? When matched for intelligence, on the other hand, whites and Negroes are considerably more alike in memory, and they average just about the same in memory performance when matched on intelligence in the vicinity of 100 IQ. In other words, it appears that if Ss have the intelligence, they have the memory; while if they have the memory, they do not necessarily have the intelligence.

Dispersion of Memory Ability as a Function of Intelligence

If it is true that intelligence depends upon memory but that the reverse does not hold, we should expect the dispersion of memory scores to show a systematic decrease going from low to high levels of intelligence. To test this hypothesis the standard error of estimate of memory scores (i.e., the standard deviation of memory scores around the regression line of memory upon intelligence) was examined for systematic change over the full range of Lorge-Thorndike Verbal and Nonverbal intelligence test scores. The results are shown in Figure 9. Since the standard error of estimates (indicated by circles) are

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Insert Figure 9 about here

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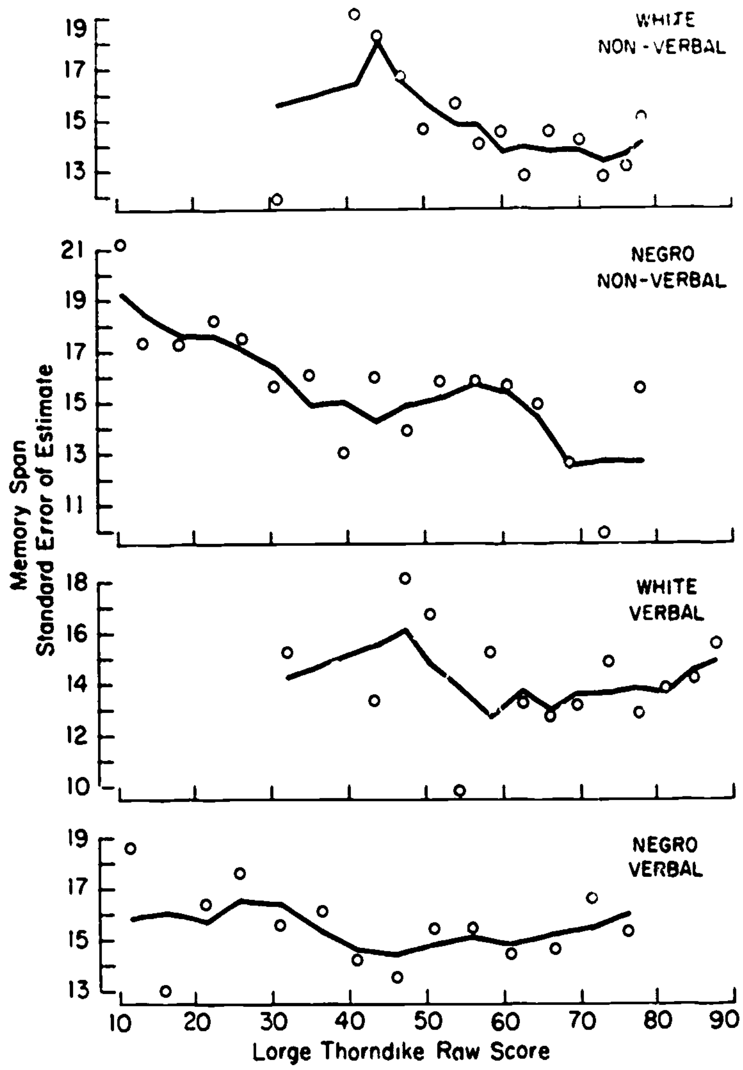

Fig. 9. Memory score dispersion (standard error of estimate) as a function of Lorge-Thorndike verbal and nonverbal raw scores in white and Negro groups.

rather erratic, their trend is better indicated by a moving average (the line going through the data points). For the Nonverbal test the trend is clearly in accord with the hypothesis; i.e., the standard error of estimate of the memory scores systematically decreases with increasing Nonverbal intelligence. Bartlett's test for homogeneity of variances and a test of trend are both significant beyond the .01 level both for whites and for Negroes. The results for the Verbal test, however, yield only a faint suggestion of a decreasing standard error of estimate and the trend is nonsignificant.

Thus the prediction based on the hypothesized hierarchical relationship between Level I and Level II is borne out by the Nonverbal but not by the Verbal test. Why should the two tests differ in this way? One can only speculate at this point. A possibility is that while both tests are highly saturated with g, the Nonverbal test is more a measure of what Cattell (1971, Ch. 5) calls "fluid" g and the Verbal test is more a measure of "crystalized" g. The hypothesized hierarchical relationship between Level I and Level II may hold only for Level II as measured by tests of fluid g. But this conjecture cannot be tested with the present data and must await a study specially designed for this purpose.

SES Differences Within Racial Groups

A questionnaire sent to the home of every child in the study, as well as the school records, served as the basis for classifying Ss according to SES. Among other items of family background information obtained from the parents was the current occupation (or last job held in case of the unemployed) of the head of the household. Since returns of the parental questionnaire were considerably less than one hundred percent, especially in the Negro group, and not all the questionnaires that were returned had answered the occupation question,

the sample size for the SES analysis was reduced and the remaining Ss cannot be regarded strictly as a random sample of the Berkeley school population because of the self-selection in answering the questionnaire. When parent's occupation was not given in the questionnaire it was sought in school records, but often without success. If the parental occupation appeared in the school records, it almost invariably was given in the questionnaire and vice versa. Lack of information or ambiguity or doubt in the SES classification of a given occupation were causes for omitting Ss from the present analysis.

Parental occupations were first coded into 82 job description categories. These were then reduced to seven categories in terms of conventional SES rankings of the occupations. But in order to obtain large enough SES samples to allow tests of Level I-Level II correlations and regressions within each sample, these seven categories had to be reduced to three broad SES categories, labeled High, Middle, and Low, as follows:

High SES	1. High level administrators, supersivors, college teachers.
	2. High level professionals, engineers, physicians, etc.
Middle SES	3. White collar occupations requiring college or technical training.
	4. Self-employed, technicians, skilled craftsmen.
	5. Merchants, managers of small business, service workers, contractors.
Low SES	6. Manual workers.
	7. Nonmanual workers, relatively unskilled, jobs ordinarily requiring less than a high school diploma.

The categories are admittedly crude and somewhat artibrary, but would undoubtedly correlate highly with any of the various methods of SES classification.

Table 4 gives the means and SDs of the three SES groups within each race.

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Insert Table 4 about here

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The "Total" is based on the Ss who were classifiable. "Population" consists of all Ss on whom test data were available, whether they were classifiable by SES or not. It can be seen that the "Total" and "Population" do not differ appreciably in means or SDs, which indicates that the Ss who were classified by SES are a fairly representative sample of the school population, at least as regards the present test variables.

Though there are the expected differences between each of the SES levels, among whites the largest differences are seen between the Middle and Low groups, while among Negroes the largest differences are between the High and Middle SES levels. But this difference between the racial groups is of little significance, since whites and Negroes are not perfectly matched for occupations within the three broad SES categories. The average racial difference (last column of Table 4) within each SES level is slightly larger than the High-Low SES differences within each race for the Lorge-Thorndike Verbal and Nonverbal scores. For the Memory scores, on the other hand, the High-Low SES difference within each racial group is greater than the difference between the racial groups. Expressed in units of the white population σ, the High-Low SES difference for whites on the L-T Verbal = .90, on Nonverbal = .90, on Memory = .59; the corresponding figures for Negroes are: 1.02, .86, and .52. In both

Table 4

Means and SDs of Intelligence and Memory Raw Scores

of SES Levels Within Racial Groups

Test	SES	White N	White Mean	White SD	Negro N	Negro Mean	Negro SD	Difference[3]
L - T Verbal	High	763	71.6	10.40	38	58.4	13.22	1.05
	Middle	287	70.9	9.98	43	50.5	15.68	1.63
	Low	215	60.3	16.42	414	45.7	15.99	1.17
	Total[1]	1,265	69.6	12.24	495	47.2	16.19	1.79
	Pop.[2]	1,489	69.9	12.56	1,123	46.2	16.88	1.88
L - T Nonverbal	High	763	65.3	8.75	38	52.3	11.36	1.20
	Middle	287	63.6	9.61	43	46.6	12.04	1.57
	Low	215	55.6	14.82	414	43.0	13.63	1.16
	Total[1]	1,265	63.4	10.72	495	44.1	13.59	1.78
	Pop.[2]	1,489	63.1	10.83	1,123	43.5	14.50	1.81
Memory (Total Score)	High	763	74.7	15.23	38	69.0	16.12	0.37
	Middle	287	73.7	14.01	43	63.4	16.65	0.66
	Low	215	65.5	15.28	414	60.9	16.76	0.30
	Total[1]	1,265	72.9	15.34	495	61.7	16.86	0.72
	Pop.[2]	1,489	74.5	15.58	1,123	62.5	16.82	0.77

[1] Total of all Ss who were classified by SES.

[2] The entire school population in Grades 4-6.

[3] $\frac{\bar{W}-\bar{N}}{\sigma_W}$

racial groups the High-Low SES difference is almost twice as great for the intelligence tests as for the memory test, which accords with the hypothesis at least in a directional sense, i.e., Level II ability is more highly correlated with SES than is Level I ability.

Correlations and Regressions Within SES Groups. Table 5 shows the correlation and regression of memory upon intelligence in each of the SES

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Insert Table 5 about here

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groups by race. The theory predicts higher correlations and regression coefficients in upper than in lower SES groups. This is not completely borne out by the data. The white SES groups show no systematic trends in this respect, but the Negro SES groups show the predicted trend, i.e., lower correlations and regressions with lower SES. The Negro High and Middle SES groups both appear quite different from the Negro Low SES group. The differences of regression coefficients between all 15 possible contrasts of SES x Race groups in Table 5 were subjected to *t* tests (two-tailed) to determine their significance. Only four of the contrasts are significant beyond the .10 level (two-tailed), as shown in Table 6.

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Insert Table 6 about here

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Table 5

Correlations ($\underline{r}$) and Regression Coefficients ($\underline{b}$) of Memory Scores

Upon Lorge-Thorndike Verbal and Nonverbal Raw Scores

in SES Levels Within Racial Groups[1]

	White				Negro			
	Verbal		Nonverbal		Verbal		Nonverbal	
SES	r	b	r	b	r	b	r	b
High	.376	.551	.361	.628	.552	.673	.594	.843
Middle	.414	.581	.324	.472	.408	.428	.496	.686
Low	.591	.550	.605	.624	.391	.410	.311	.382
Total	.464	.582	.442	.632	.419	.436	.365	.453
Population	.466	.578	.443	.637	.420	.419	.372	.436

[1]For Ns see Table 3.

Table 6

Significance of Differences Between Race and SES Groups

in Regression of Memory Upon Intelligence

Contrast	Verbal		Nonverbal	
	t	*p*	*t*	*p*
High SES White - Low SES Negro	1.83	.07	2.66	.008
Middle SES White - Low SES Negro	1.67	.09	—	—
Low SES White - Low SES Negro	1.75	.08	2.61	.008
High SES Negro - Low SES Negro	—	—	2.17	.03

All the significant differences involve exclusively the Low SES Negro group, and the only significant within-race SES difference is between High and Low SES Negroes. The difference in regressions, therefore appear to involve race more than SES, or a combination of race and SES effects, since the Low SES Negro group is undoubtedly somewhat below the Low SES white group in SES. The regressions of the High and Middle SES Negro groups do not differ significantly from those of the white groups.

Level I and Level II Factor Scores

In order to determine the relative magnitudes of the white-Negro differences in Level I and II abilities, each independently of the other, orthogonal (i.e., uncorrelated) factor scores were obtained for Level I and Level II by means of a varimax rotation of the principal components. To broaden the Level II factor, the components analysis was based on all the tests (including three forms of the memory tests) previously described in the section on Method, with the addition of 8 other variables: age (in months) and 7 of the subscales of the Stanford Achievement Tests (vocabulary, reading comprehension, spelling, grammar, arithmetic computation, arithmetic concepts, and arithmetic applications). The correlations entering into the analysis were based on the data of the combined white and Negro groups.

Four components with eigenvalues greater than 1 were extracted and rotated orthogonally to approximate simple structure by the varimax criterion. The varimax factors are clearly identifiable as a Level II factor with the largest loadings on the Lorge-Thorndike Verbal and Nonverbal Intelligence Tests followed by the Stanford-Achievement Tests, a Level I factor with highest loadings on the memory tests, and two minor factors which account for a small part of the total variance: age and speed-and-persistence (Making Xs).

The latter two factors, in effect, serve to partial these variables out of the Level I and II factors.

The mean Level I factor scores of whites and Negroes differ by 0.23 in white sigma units; the Level II difference is 1.52 σ. Both differences are highly significant; but the important point, which accords with the hypothesis, is that the white-Negro difference on the Level II factor is 6.6 times greater than on the Level I factor.

The correlations between the two varimax factors in the white and Negro groups cannot be tested, of course, since the factors were forced into orthogonality for the purpose of observing the racial difference on each factor (Level I and Level II) where the effect of the other factor is removed. In order to determine the correlation between Levels I and II, the factors must be allowed oblique rotation in achieving the closest possible approximation to a simple structure. Oblique rotation of the factors by the promax method (Hendrickson & White, 1964) was carried out separately in the white and Negro groups. The correlations between the Level I and Level II factors were .42 for whites and .33 for Negroes; the difference is significant and in the predicted direction (z = 2.69, df = 2,606, one-tailed $p < .003$).

Discussion

The present study examined three main aspects of the Level I - Level II theory of mental ability, viz., (a) the relative magnitudes of SES and white-Negro differences in Level I and Level II abilities; (b) SES and racial differences in the correlation between Levels I and II, and in the regression of Level I upon Level II; and (c) the hierarchical (i.e., necessary-but-not-sufficient) functional dependence of Level II performance on Level I ability.

(a) The theory as originally stated in its simplest form predicts an

SES difference in Level II ability but not in Level I ability. This formulation, however, was intended more as an unambiguous basis for a directional prediction than as a precise expectation of reality, for in reality it is, of course, most improbable that there is "no difference" between any two populations in any given trait. So the realistic issue is the relative magnitudes of differences between populations in Levels I and II. In accordance with previous findings, it was found that the white and Negro groups, and to a slightly lesser degree the High and Low SES groups within each race, differed much more, on the average, in Level II than in Level I ability. The exact size of the differences, of course, depend upon the particular populations being compared and is not regarded as an intrinsic aspect of the theory, the main point of which is that populations can differ in these two classes of ability, and that the direction of the difference in socioeconomically stratified populations is such that the higher and lower groups will show a greater difference on Level I than on Level II. The reason for this, according to the theory, is that social mobility in an industrialized society is more dependent upon Level II than upon Level I abilities. In the present study the white-Negro differences are larger than the SES differences within the racial groups, but the point is ambiguous here since the average SES difference between the races is probably greater than the High-Low SES differences within each racial group. The strict criteria for SES classification used here resulted in the inclusion of a peculiarly small percentage of the Negro population in the High and Middle SES categories. It would be advisable in future studies to have SES ratings on a continuous scale based on a large number of home background factors which might reflect more closely the nature of the child's environment than does merely the occupational classification of his parents.

(b) The hypothesized higher correlation between Levels I and II in the

white than in the Negro group was fully borne out by the data, as was also the predicted higher regression of Level II upon Level I. The effect is largely attributable to the difference between the entire white sample and the Low SES Negro group, which constituted the vast majority of the present Negro sample. The High SES and Middle SES Negro groups do not differ significantly from the white population in this respect, but differ significantly from the Low SES Negro group.

The cause of different Level I - Level II correlations (or regressions) in different populations has not yet been established and at present can only be hypothesized. There are several possible causes of correlation and they are not mutually exclusive: (*i*) part-whole functional dependence, i.e., one bahavior may be a subunit of some other behavior, such as shifting gears smoothly and passing a driver's test consisting of driving in traffic with an examiner present; (*ii*) hierarchical functional dependence, i.e., one behavior is prerequisite to another or one is functionally dependent upon another, as skill in working problems in long division is dependent upon skill in multiplication; (*iii*) environmental correlation between the behaviors, i.e., cultural contingencies may be such that when one behavior is learned another is also likely to be learned, even though there is no functional connection between the two behaviors, e.g., a knowledge of baseball and a knowledge of football; and (*iv*) genetic correlation between behaviors due to common assortment of their genetic underpinnings through selection and homogamy, and pleiotropism (one gene having two or more phenotypic effects). The rather low degree of correlation between our Level I and Level II tests suggests that there is little functional dependence, and this could be proved conclusively if one could find a group of *S*s which reliably showed a zero correlation between Level I and Level II. The fact of quite large and significant differences in Level I - Level II correlations

in various populations is also inconsistent with wholly functional or part-whole dependence as a cause of the correlation. Some substantial part of the correlation, therefore, must be attributable to other causes. If the cause is common environmental influences on the Level I and Level II tests, it is hard to imagine what these influences might be and why, if they are common, there should be such large group mean differences in Level II ability and not in Level I. The most reasonable hypothesis at this point would seem to be that the correlation is due only slightly to functional dependence of Level II upon Level I, and mostly to a common genetic assortment on both factors, i.e., a genetic correlation in the population between two broad classes of ability with different genetic underpinnings. If this were the case, we might find a wide range of correlations in different populations; one conceivably might even find a goup in which the correlation is negative. This would tend to rule out pleiotropy and would suggest independent mechanisms under independent genetic control underlying Level I and Level II. Specially designed studies would be required to test such a hypothesis.

(c) The test of the hypothesis of hierarchical dependence of Level II upon Level I yielded significant evidence consistent with the hypothesis in the case of the Nonverbal intelligence test but not the Verbal. In any case, there does not appear to be evidence of any strong degree of functional dependence between the abilities; quite low or high scores on the one ability are not incompatible with a high or low score on the other, thought there is a tendency for low intelligence-high memory to be more frequent than the opposite combination of abilities, especially for nonverbal intelligence.

In the present study, Level I ability was measured by three slightly differing forms of a single type of test--digit span memory. In other studies different tests have been used--paired-associates learning, serial learning,

and free recall of pictures and objects--all with similar results generally consistent with the formulation of the two-level theory. But what is not yet established is whether Level I abilities represent a common factor (just as Spearman's *g* is the common factor in the kinds of intelligence test performance that typify Level II ability) or whether Level I is merely a collection of abilities that have no common factor (i.e., there are only low or negligible correlations among the various Level I tests) but do have certain characteristics in common such as their low correlation with tests of intelligence and relatively small degree of relationship to SES and race differences as compared with Level II tests. There is not much point in speculating about this, since other studies aimed at answering these questions are now in progress.

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